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US 3934984 A

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(54) Inflator device for deployment of a motor vehicle passenger passive restraint system

(57) The invention relates to a motor vehicle passive restraint system comprising a gas generator for inflating an air bag attached thereto. The generator (10) comprises a mounting plate assembly (12) having a base plate, a recessed portion(18) for receiving and supporting a diffuser plate (22) and means for receiving and attaching the air bag (32). The mounting plate assembly is integrally constructed of a relatively light weight material capable of being stamped utilizing conventional stamping equipment. The generator additionally comprises a diffuser plate (22) with a plurality of gas exhausts (30). The diffuser plate (22) further comprises a support plate configured for connection to the recessed portion of the mounting plate assembly, and at least one integral side wall portion extending from the support plate. The diffuser plate (22) is conected to the mounting plate assembly (12) in a manner to permit a minimal degree of separation between the diffuser plate and the mounting plate assembly in the event the system becomes over-pressurized. Included within the generator is a gas generant composition. The mounting plate assembly and diffuser plate form a housing for this gas generant composition.

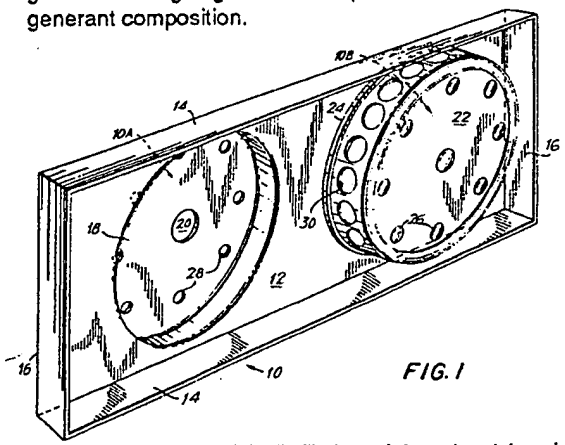

FIG. 1

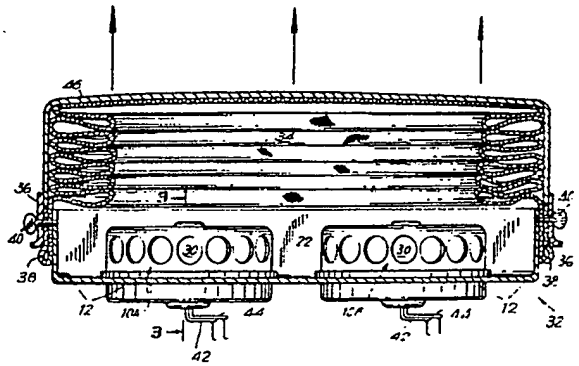

FIG. 2

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1982.

At least one of these pages has been prepared from an original which was unsuitable for direct photoreproduction.

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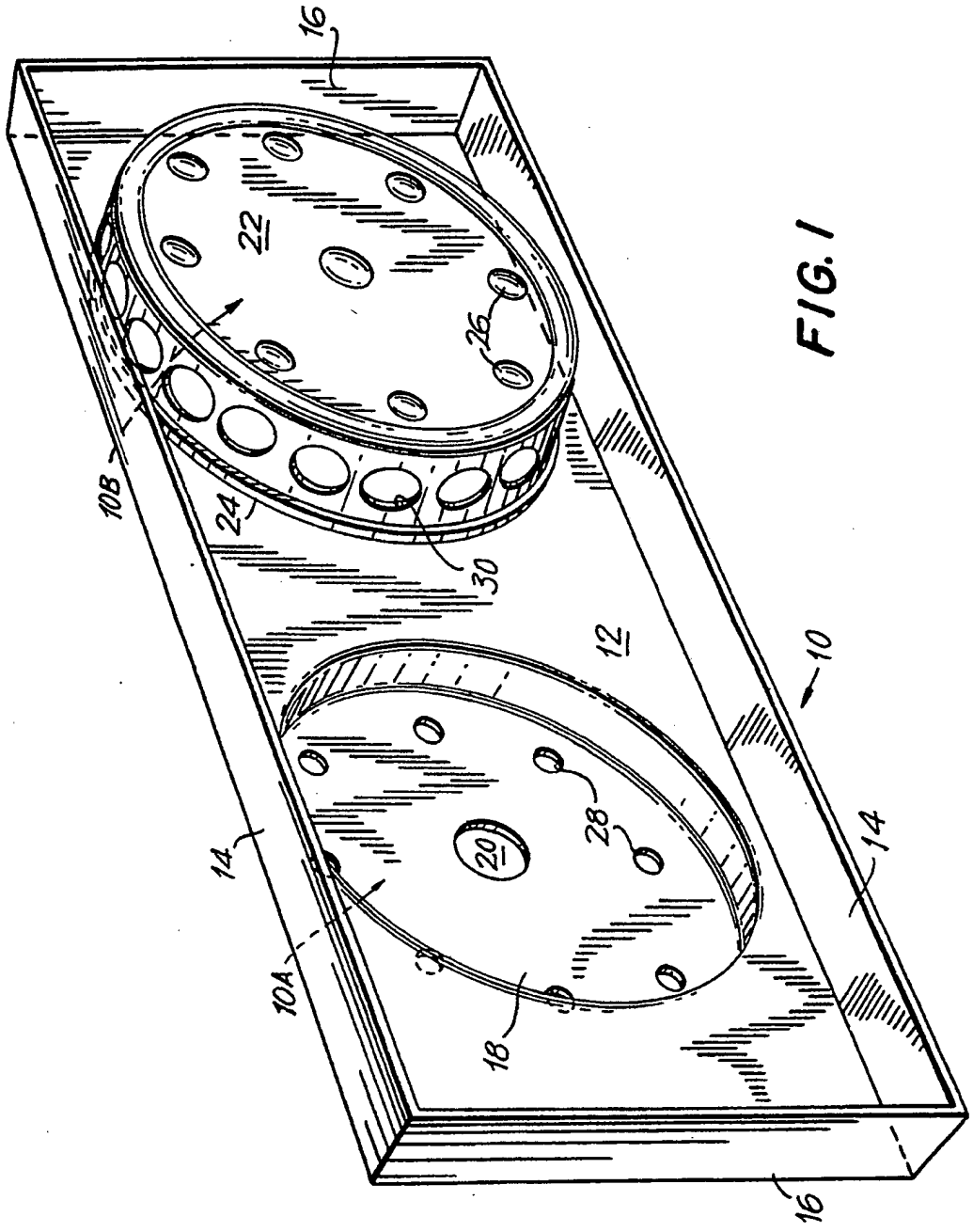


FIG. 1

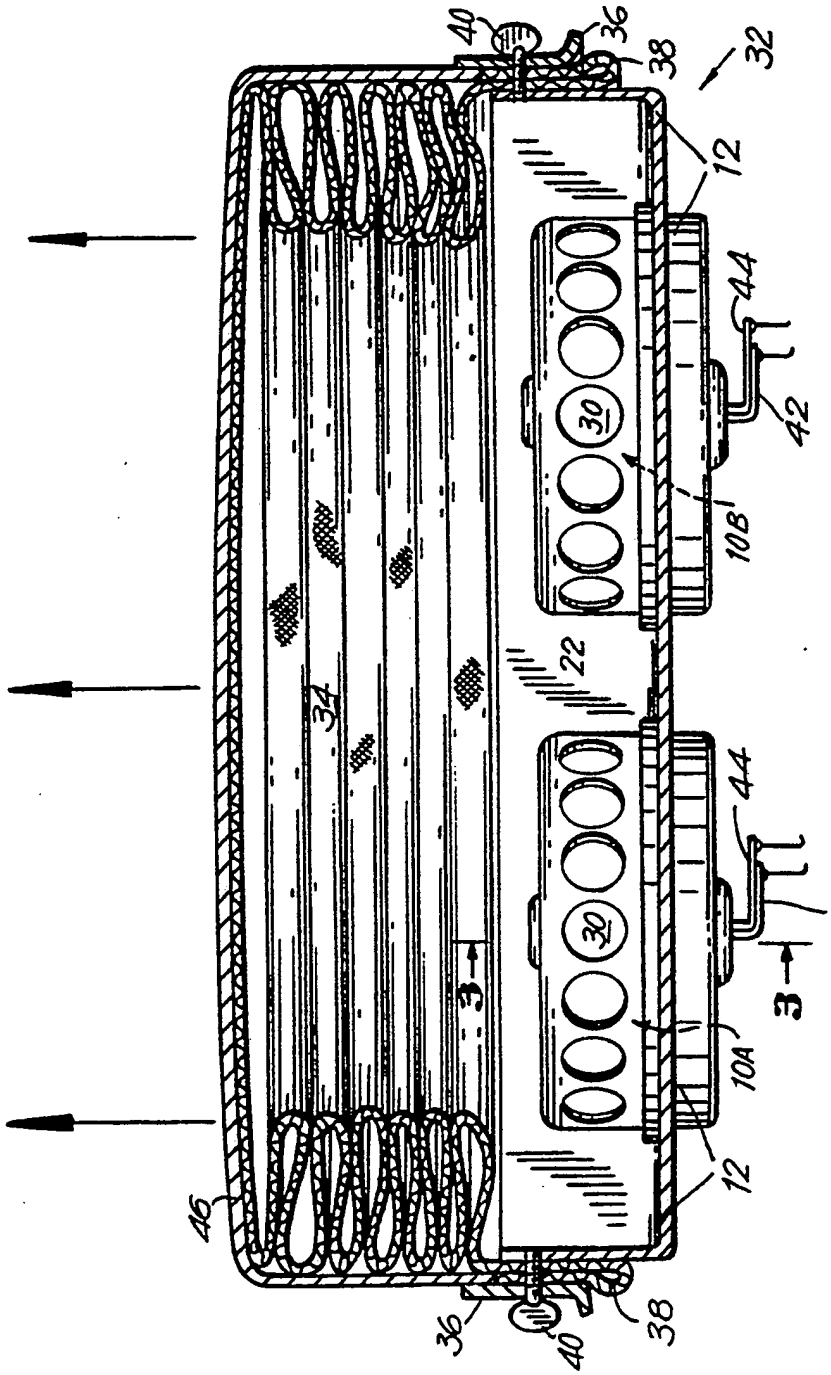
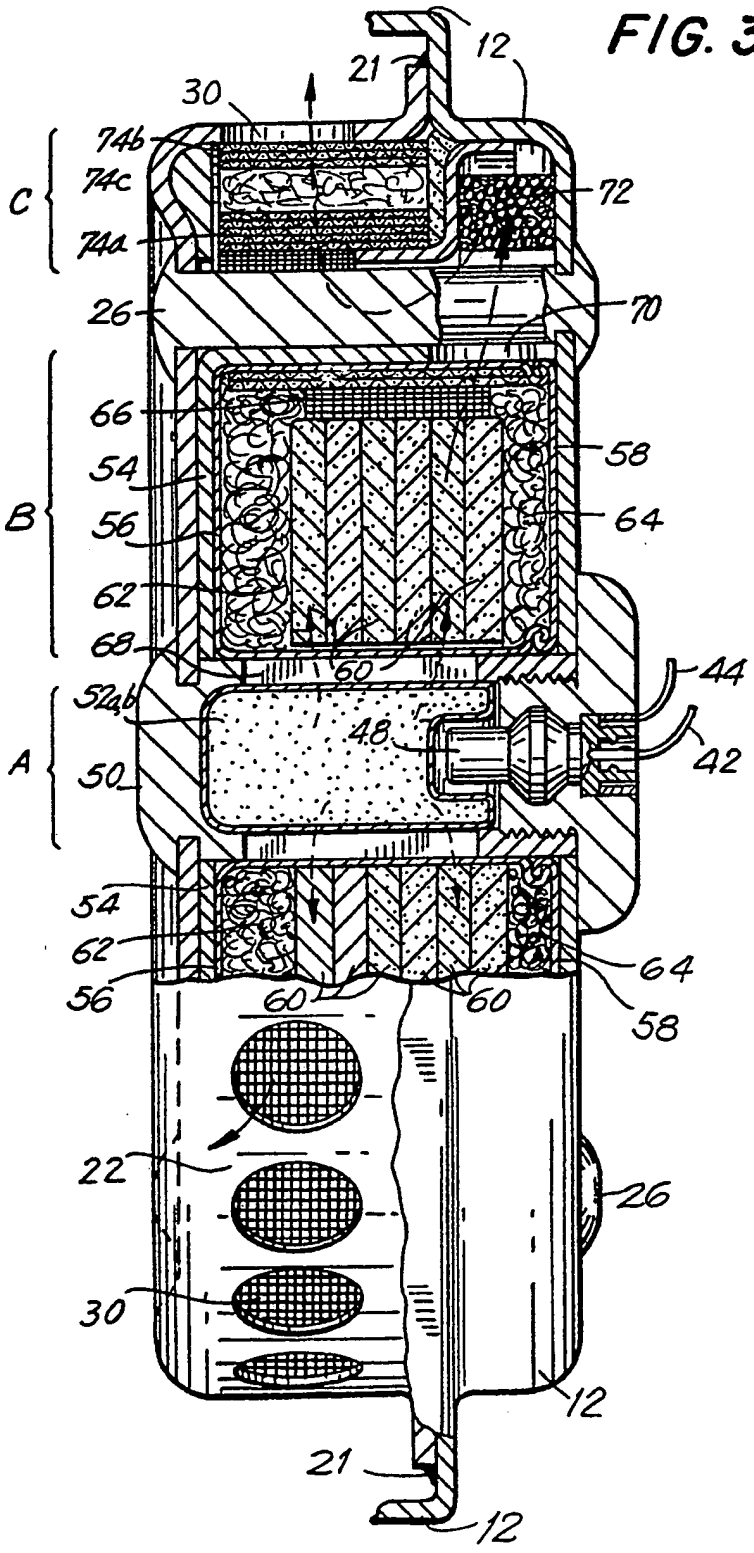


FIG. 2

FIG. 3


12
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INFLATOR DEVICE FOR DEPLOYMENT OF A MOTOR VEHICLE PASSENGER PASSIVE RESTRAINT SYSTEM

The invention relates to an "air bag" passive restraint system for protecting motor vehicle passengers from injury in the event of a collision and more particularly to an inflator device for deploying the air bag within the passenger compartment of the automobile.

Various types of gas generators or inflators, utilizing combustible solid fuel gas generating compositions for the inflation of the crash protection, i.e., "air bag" restraint systems are known in the prior art. There are, however, differing requirements concerning inflation devices used for passenger side air bag systems in contrast to those utilized to deploy air bags on the driver's side of the vehicle.

One major difference between the two types of gas generators is that the inflation of a passenger air bag requires a generator capable of producing a significantly greater amount of gas than does a driver's side unit. This is due to the fact that, generally, the volume of a passenger air bag is 2 to 3 times that of the bag used to protect the driver, due to the need to cover a wider area in which the passenger(s) may be seated during an accident. While the driver is normally located in a fixed position behind the steering wheel, a passenger in the front seat of the vehicle may be seated, for instance, next to the driver or against the passenger side door, or anywhere in between.

The currently practiced method for achieving inflation of these large-volume passenger restraints involves: 1) the use of a linear inflator or, 2) two or more driver's side units may be assembled onto a specially fabricated mounting plate. The first of these two

alternate techniques, i.e., the linear inflator, comprises an elongated cylinder approximately fourteen inches in length and two inches in diameter, having a series of exhaust orifices located along its longitudinal axis. The inner surface of the inflator is provided with a layer of a suitable screening material to act as a filter, and a layer of a solid gas generating composition is packed between the filtering screens. Once the generant is ignited by a suitable initiator device, such as an electrically actuated squib, the gas thus produced is directed through the filters and out of the generator through the exit ports where it is utilized to inflate the bag. This device is both difficult to produce and cumbersome to install and operate.

With regard to the second instance cited above, certain manufacturers have fabricated a special mounting plate at additional expense which provides a labor intensive method of joining two driver's side inflator units together. This plate is very expensive to produce since it requires extensive machining in order to meet the required tolerances posed by the incorporation of the pre-constructed generators and the subsequent installation of this assembly in the dashboard of an automobile.

Further, with regard to the inflation of such air bag systems as have been employed in the prior art, many forms of gas generators utilizing combustible solid fuel gas generating compositions are known. Commonly encountered features among generators utilized for this purpose are the inclusion within a housing of a gas generant composition and means to filter and to cool the gas, positioned between the composition and the gas discharge orifices, as defined by the generator housing.

One such gas generator includes an annular combustion chamber which is bounded by an outer casing or housing structure. The combustion chamber encloses a rupturable

container or cartridge that is hermetically sealed and which contains therein a solid gas generant in pelletized form, surrounded by an annular filter. This generator further includes a central ignition or initiator device and a toroidal filter chamber adjoining and encircling the combustion chamber. An inner casing or housing structure is located in close surrounding and supporting relationship to the rupturable container, the inner casing being formed by a cylinder having uniformly spaced peripheral ports or orifices near one end. These orifices provide exit holes for the flow of gas from the combustion chamber.

Alternately, a generator housing may be provided, comprising first and second structural components or shells, specifically, a first or diffuser shell and a second or base shell. Both shells are forged and heat treated, after which they undergo machining to obtain a proper fit. The first structural component, i.e., the diffuser shell, is formed with three integral concentric cylinders which form the inner structural walls of the inflator and which define chambers therein containing the solid gas generant, ignition materials, and filters, as well as providing exit openings or ports for the passage of the gasses from chamber to chamber and subsequently into the protective air bag.

The second structural component of this embodiment, known as the base shell, may contain an electrical initiator, e.g., a squib, for igniting the main propellant charge as well as a flange for attaching an air bag thereto. It also provides three concentric mating surfaces for the concentric cylinders of the diffuser shell. The three concentric cylinders of the diffuser shell are thus joined to the corresponding concentric mating surfaces located upon the base shell.

Gas generators, or inflators, of the type described above, must withstand enormous thermal and mechanical stresses for a short period during the gas generation process. Thus, inflators that have been and are currently being used with automobile or other vehicle air bags have previously been fabricated using steel for the casing and other structural housing components, with these components being joined together by screw threads, roll crimping or welding.

The recent emphasis on weight reduction for the purpose of fuel conservation in motorized vehicles, however, has created a need and a demand for a lighter weight inflation system. The availability of a light weight inflator enables automobile manufacturers to reduce the total weight of their vehicles, thus positively affecting the gas mileage obtainable by models so equipped, which is an important selling point in today's market.

In this regard, some recently introduced inflator devices utilize aluminum casing materials. While this does alleviate somewhat the problem of excessive generator weight, aluminum generators tend to be more expensive in terms of production costs than the stamped stainless steel models currently in general use. More importantly, however, aluminum also tends to lose considerable strength at elevated temperatures, which becomes of concern should the airbag system be exposed to a car fire. Since the gas generator is a pressure vessel, as noted above, concern exists over the possible fragmentation of a weakened aluminum generator casing upon a sudden overpressurization of the device due to an ignition caused by such a fire.

The present invention provides a motor vehicle passive restraint system which comprises gas generator means capable of operation in the event of a collision involving said motor vehicle to produce a sufficient amount of a cool gaseous product, substantially devoid of undesirable particulate matter, to substantially inflate air bag means attached thereto in order to prevent secondary collisions between any occupants of said vehicle and an interior portion thereof, said generator means comprising a mounting plate assembly comprising a base plate a recessed portion for receiving and supporting a diffuser plate and means for receiving and attaching an air bag, said means located along a peripheral portion of said mounting plate assembly, said mounting plate assembly being integrally constructed of a relatively light weight material capable of being stamped utilizing conventional stamping equipment without any need to machine said assembly, a diffuser plate having gas exhaust means configured and adapted for the passage of said gaseous product therethrough, said diffuser plate comprising a support plate configured for connection of said diffuser plate to said recessed portion of the mounting plate assembly and at least one integral side wall portion extending from said support plate, said diffuser plate being connected to said mounting plate assembly so as to cover said recessed portion and in a manner so as to permit a minimal degree of separation between said diffuser plate and said mounting plate assembly in the event said system become overpressurized and a gas generant composition capable of combustion so as to produce a desired amount of said gaseous product to inflate said air bag within less than about 60 milliseconds, said mounting plate assembly and said diffuser plate forming a housing for said gas generant composition and air bag means attached by said receiving

and attaching means to said mounting plate assembly and capable of inflation by said gaseous product produced by the operation of said generator means to protect said occupants during said collision.

In an embodiment of the invention, the mounting plate assembly may comprise at least two recessed portions. Each of these portions are configured and adapted for receiving and supporting a diffuser plate. Alternately, each recessed portion may be configured and adapted for supporting a separate, corresponding diffuser plate.

The diffuser plate of this embodiment may be connected to the mounting plate assembly by fasteners passing vertically through apertures defined by an outer peripheral portion of both the support plate and the recessed portion. These fasteners may be, for example, bolts, rivets or screws. In an alternate embodiment, the diffuser plate may further comprise a flanged portion located along a peripheral portion of the diffuser plate. The flanged portion may thus be connected to the mounting plate assembly by a weld.

In a further embodiment of the invention, the means for receiving and attaching the air bag to the mounting plate assembly comprises a retainer ring mounted around a peripheral portion of the mounting plate assembly and fastener means for tightening the ring over a mouth portion of the air bag. In addition, the restraint system further comprises means connected to the mounting plate assembly for mounting the system in a dashboard of a motor vehicle.

An alternate embodiment of the invention comprises a motor vehicle passenger passive restraint system. This system comprises a gas generator capable of operation in the event of a collision involving the vehicle to produce a sufficient amount of a cool gaseous product, substantially devoid of undesirable particulate matter, to substantially inflate an air bag. The air bag is inflated in order to prevent secondary collision between any occupants of the vehicle and an interior portion thereof.

The gas generator comprises a mounting plate assembly having a base plate, a recessed portion for receiving and supporting a diffuser plate and means for receiving and attaching an air bag, these means being located along a peripheral portion of the mounting plate assembly. The mounting plate assembly is integrally constructed of a relatively light weight material capable of being stamped utilizing conventional stamping equipment without any need to machine the assembly.

The generator further comprises a diffuser plate having a gas exhaust configured and adopted for the passage of the gaseous product therethrough. The diffuser plate comprises a support plate configured for connection to the recessed portion of the mounting plate assembly and at least one integral sidewall portion extending from the support plate. Further, the diffuser plate is conected to the mounting plate assembly so as to cover the recessed portion and in a manner so as to permit a minimal degree of separation between the diffuser plate and the mounting plate assembly in the event the system becomes overpressurized. Additionally, the gas generator contains a gas generant composition capable of combustion so as to produce a desired amount of the gaseous product to inflate the air bag within less than 60 milliseconds.

The mounting plate assembly and the diffuser plate together form a housing for the gas generant composition. This housing further comprises at least three concentrically aligned toroidal zones. A first zone contains means for igniting the gas generant composition. A second zone contains the solid gas generant composition itself, operable upon ignition to produce gas and particulate reaction products. The third zone contains filtration means to cool the gas and to trap the particulate products. The third zone is further provided with gas exhaust means for discharging gas through the diffuser plate.

The passenger passive restraint system of the invention additionally comprises an air bag attached to the mounting plate assembly of the gas generator which is capable of inflation with the gaseous product produced due to the operation of the generator to protect the occupants during the collision.

In an alternate embodiment of the invention described above, the passive restraint system may further comprise at least two recessed portions, each of which are configured and adapted for receiving and supporting a diffuser plate. Alternately, each recessed porton may be configured and adapted for supporting a separate, corresponding diffuser plate. The diffuser plate(s) may be connected to the mounting plate assembly by fasteners passing vertically through apertures defined by an outer peripheral portion of the support plate and the corresponding recessed portion. These fasteners may be, for example, bolts, rivets or screws.

In a further embodiment, the diffuser plate of the invention may additionally comprise a flanged portion located along a peripheral portion of the sidewall portion. The flanged portion is preferably connected to the base plate by a weld. Further, the means for

receiving and attaching an air bag to the mounting plate assembly comprises a retainer ring mounted around a peripheral portion of the mounting plate assembly and fastener means extending through the ring for tightening the ring over a mouth portion of the air bag. The system may also include means connected to the mounting plate assembly for mounting the system in the dashboard of a motor vehicle.

The first zone of the generator housing as described above may contain an enhancer packet comprising a homogeneous mixture of an ignition enhancing material and an auto ignition composition. Further, the second zone comprises pre-filtering means located along an outer peripheral portion thereof. The pre-filtering means comprises at least one layer of a screen positioned so as to remove a portion of the particulate products from the gas.

The third zone of the generator housing includes a first portion containing first filtering means for removal of a major portion of the particulate reaction products from the gas and a second portion containing second and third filtering means for removing substantially all of any remaining particulate reaction products from the gas. The gas passes through the second filtering means prior to passing through the third filtering means. The particulates however, due to their relatively greater mass, fly directly into the first filtering means, where they are subsequently trapped.

The first filtering means, described above, comprises a chamber substantially filled with a plurality of unaligned metal fibres such as, e.g., steel wool. The second filtering means comprises one or more screens having a predetermined mesh size. This mesh size is sufficient to prevent the passage therethrough of substantially all of the particulate reaction products normally occuring in the gas. The third filtering means comprises one or more screens having a mesh size

relatively narrower than that utilized with the second filtering means. In the invention described above, the gas exhausts are a plurality of diffusion ports located along a peripheral portion of the diffuser plate, adjacent and exterior to the third filtering means.

An alternate embodiment of the invention comprises a motor vehicle passenger passive restraint system. This restraint comprises a gas generator capable of operation in the event of a collision involving the motor vehicle to produce a sufficient amount of a cool, gaseous product, substantially devoid of undesirable particulate matter, to substantially inflate an air bag attached thereto. The air bag is deployed in order to prevent secondary collisions between any occupants of the vehicle and an interior portion thereof.

The generator comprises a mounting plate assembly having a base plate, at least two recessed portions for receiving and supporting a diffuser plate and means for receiving and attaching an air bag. These receiving and attachment means are located along a peripheral portion of the mounting plate assembly. Preferably, the mounting plate assembly is integrally constructed of a relatively light weight material capable of being stamped utilizing conventional stamping equipment without any need to machine the assembly.

The generator of this embodiment may additionally comprise a separate diffuser plate corresponding to each of the recessed portions. Each of these diffuser plates is provided with exhausts configured and adapted for the passage of the gaseous product therethrough. Each diffuser plate comprises a support plate configured for connection of the diffuser plate to the corresponding recessed portion of the mounting plate assembly and at least one integral side wall portion extending from the support plate. Each diffuser plate is connected to the

mounting plate assembly so as to cover a corresponding one of the recessed portions and in a manner so as to permit a m imal degree of separation between one or more of the diffuser plates and the mounting plate assembly in the event the system becomes overpressurized.

The generator contains a gas generant composition capable of combustion so as to provide a desired amount of gaseous product to inflate the air bag within less than about 60 milliseconds. Each unit, comprising a recessed portion and a corresponding diffuser plate, forms a housing containing a predetermined amount of the gas generant composition. Each housing further comprises at least three concentric toroidal zones.

A first zone of the housing contains a device for igniting the gas generant composition. A second zone contains the solid gas generant composition itself, operable upon ignition to produce gas and particulate reaction products. A third zone contains a filter to cool the gas and to trap the reaction products. The third zone is further provided with gas exhaust means.

An enhancer packet, located within the first zone, comprises a homogeneous mixture of an ignition enhancing material and an auto ignition composition. Spacer means are positioned betwen the solid gas generant composition and the housing to prevent abrasion of the composition due to contact with an inner surface of the housing. Pre-filtering means are located along a peripheral portion of the first zone between the solid gas generant composition and the third zone. Filtering means are located in the third zone. These filtering means comprise a first portion for removal of a major portion of the particulate reaction products in the gas and a second portion for removing substantially all of any remaining particulate reaction products. The gas passes through the first portion of the filtering means prior to passing through

the second portion. The passenger passive restraint system of the invention additionally comprises an air bag capable of inflation by the gaseous product produced due to the operation of the generator to protect the occupants of the vehicle during a collision.

There will now be described, with reference to the drawings, an example of apparatus according to the invention, the description being given by way of example only and not by way of limitation:

In the drawings:-

FIG. 1 is a perspective view of a partially constructed gas inflator unit for use in a passenger passive restraint device according to the invention;

FIG. 2 is an upper plan view, partially in section, of the passenger passive restraint device, and

FIG. 3 is a sectional view on line 3-3 of FIG. 2.

As will become apparent from the following discussion concerning the attached drawing figures, the apparatus adopted for use in the present invention is a hybrid of those utilized in the prior art in that the mounting, i.e., base, plate is constructed as an integral (lower) portion of the inflator. That is, in the present invention, a single, specially formed mounting plate may serve as a base portion for at least two upper diffuser plates, which are connected thereto.

Turning initially to FIG. 1, there is illustrated generator assembly 10 comprising two gas generating units, 10(a) (shown only partially constructed) and 10(b). Plate 12 has upper and lower walls 14 and side walls 16 and it is preferentially formed of a stamped metal sheet comprising a relatively light weight material capable of retaining a high tensile strength in the event it is subjected to elevated temperatures, such as those which

may be encountered during a car fire. A preferred example of such a material is 301 annealed stainless steel. The invention should not be limited to this particular material, however, since there are a number of materials well known to those in the art which combine the features of high strength and reduced weight, even at high temperatures, which could also be used to form the assembly.

The stamping method is preferred for forming the various portions of the generator assembly 10 in order to avoid the additional cost and extended assembly time inherent in the use of machined parts which, as noted above, are very labor intensive to produce and which require highly skilled (and highly paid) craftsmen to produce. In contrast, a stamping machine requires less skill to operate and it may thus be used to produce parts for assembly 10 more rapidly and more inexpensively than with the use of machining techniques.

Plate 12 is preferably provided with two recessed portions 18. In the central portion of each recess 18, an aperture 20 is provided for the insertion of an initiator device, such as an electrically activated squib for igniting the solid, gas generating propellant composition stored therein. Alternately, however, any effective means for initiating the combustion of the propellant may be utilized. Further, each recess is adapted and configured to accept an upper diffuser plate 22. Diffuser plate 22 preferably includes flange 24, extending completely around the peripheral portion of plate 22, which is placed in contact with the surface of plate 12 when plate 22 is mounted on plate 12. In the preferred embodiment of the invention, flange 24 may be initially connected to plate 12 by means of a light plasma or laser weld 21 (shown in FIG. 3) between flange 24 and plate 12.

Diffuser plate 22 is further connected to base plate 12 with a plurality of connecting members 26, preferably rivets, which pass through pre-punched apertures 28 stamped in the upper, lateral surface of the diffuser plate and through corresponding holes punched in the bottom of plate 12. These connecting members 26 maintain diffuser plate 22 in proximity to plate 12 in the event that one or more generator units 10A, 10B become overpressurized.

Should such a situation occur, however, the weld along flange 24 of diffuser plate 22, connecting plate 22 to base plate 12, is designed to give way while connecting rivets 26 permit a slight separation between plates 22, 12 in order to release the gas away from the passengers in a safe, ductile manner. This prevents an explosive fragmentation of one or both of the generator units 10a, 10b. Under normal operating conditions, the gas produced by each generator unit 10A, 10B is exhausted through a plurality of discharge ports 30 into an air bag (not shown), which subsequently inflates to protect the passengers.

FIG. 2 illustrates a completely assembled passenger air bag passive restraint system 32. The system preferably comprises base plate 12 provided with, for example, two recessed portions 18 (shown in FIG. 1), each of which is capped with a diffuser plate 22. Each diffuser plate 22 has a flanged portion 24 along its peripheral edge for welding the diffuser to the base plate. In addition, each diffuser plate 22 is provided with a plurality of gas discharge ports 30 in an outer peripheral portion thereof. While the preferred restraint system utilizes two integrally formed generator units 10A, 10B, various alternate embodiments of the present invention, useful for a number of different applications, may contain a different number of inflator units.

The passenger air bag 34 is secured to the outer periphery of base plate 12 by retainer ring 36, located around the periphery of plate 12. Bag 34 is doubled over in the area of ring 36 to form a sewn welt portion 38. Welt 38 is kept from slipping off of plate 12 during the inflation of bag 34 by fasteners 40 extending through ring 36, bag 34 and base plate 12. Fasteners 40 may be, for example, bolts, screws or rivets. Alternate means, such as an adhesive, may also be used to secure bag 34 to plate 12.

Once the assembly 10 is installed in the dashboard of an automobile, with the upper portion thereof (designated by the arrows) facing inwardly toward the passenger, the initiator device, (not shown) which is preferably an electrically actuated squib, is connected by means of electrical leads 42, 44 to sensor devices (not shown) positioned in various locations on the automobile to detect an abrubt reduction in the speed of the vehicle and/or a collision with another object. As noted above, various alternate means of initiating the combustion of the solid gas generating material well known to those in the art, are perfectly acceptable and may also be utilized.

During the installation of assembly 10, bag 34 is folded atop diffuser plates 22 of generator units 10A, 10B and decorative panel cover 46, provided by the automobile manufacturer, is installed over the assembly 10 so as to provide a pleasing aesthetic appearance within the interior of the vehicle. In the event of a collision involving the vehicle, the remote sensors serve to activate the initiator device which operates to ignite the solid propellant mixture and inflate bag 34. The force generated by the inflation of bag 34 causes cover member

46 to detach from its mounting and fall to the floor of the car while bag 34 deploys to prevent injury to the passengers.

FIG. 3 is a sectional view through one of the gas generating units, i.e., 10A, in assembly 10. It illustrates the "clamshell" type sealing arrangement between base plate 12 and diffuser plate 22 with the use of rivets 26, and depicts the sinuous path taken by the gas flow within each generator unit 10A, 10B, which serves to filter and cool the gaseous combustion product. This tortuous gas path, which is another novel feature of applicants' invention, will be further described in detail below. While the basic method of operation for gas generators of the type disclosed herein is well known and need not be discussed in depth, applicants' generator units have several novel features which will be described below in further detail.

Each unit 10A, 10B defines three concentrically arranged toroidally shaped chambers which may be designated as ignition chamber (A), combustion chamber (B) and filtration chamber (C) as one moves from the center to the periphery of each unit. Ignition chamber (A), the innermost annular portion of unit 10 A, for example, contains ignition means, such as, preferably, an electrically activated initiating squib 48. Squib 48, containing a small charge of electrically ignitable combustible material, may be connected to at least one remote sensing device (not shown), of a type well known in the art. These sensing devices may be located within, for example, the front bumper or side fender of an automobile, and connected to the generator by electrical leads 42, 44.

The ignition chamber also contains enhancer packet 50 having a quantity of an enhancer material, such as a commonly employed boron potassium nitrate ($BKNO_3$) mixture which is preferably employed in a powdered form 52(a) in

order to provide the maximum available burning surface so as to engender the fastest possible response. Other rapidly combustible materials known to those in the art may be utilized for the same purpose but applicants have obtained a consistently high degree of performance with the use of $BKNO_3$.

While $BKNO_3$ is very successful in igniting the main propellant charge located in combustor chamber (B), it suffers from a serious deficiency in that the autoignition temperature of this material is extremely high, i.e., from about 315-370°C (600-700°F). Since the composition chosen for the main propellant charge of generators 10A and 10B ignites at an even higher temperature in the conditions normally encountered in, for example a car fire, the ignition material within the unit would be at a temperature in excess of 315°C (600°F) before ignition would take place.

In such a situation, the generator housing would be subjected to even higher temperatures, i.e., in the range of from about 426-482°C (800-900°F), and the main propellant charge would also be at a high temperature, perhaps 204-260°C (400-500°F). Under these conditions, under laws of temperature and pressure well known to those skilled in the propellant art, the propellant charge would burn very rapidly and generate gas at an extremely high pressure, thus creating a situation wherein an explosive fragmentation of the weakened inflator housing was a distinct possibility.

Applicants have therefore incorporated an autoignition material 52(b) with the $BKNO_3$ in enhancer packet 50. This material is capable of autoignition at a lower temperature than $BKNO_3$. Its use results in an ignition of the main propellant charge while this charge is at a much lower temperature than that described above. Thus, the propellant charge may be burned at a much lower rate and produces a significantly lower pressure.

This additional "auto ignition" material is preferably a stabilized nitrocellulose composition such as IMR 4895, which autoignites at less than about 204°C (400°F). This preferred material is produced by the DuPont Corporation, but any material capable of performing in this manner would be acceptable for use in the present invention.

The end effect of combining such an auto-ignition material with, for example, the $BKNO_3$ enhancer composition, so as to render this mixture an integral part of applicants' ignition chain is to prevent a weakening of the generator housing, thus diminishing or altogether removing the chance of an explosive overpressurization. This removes one potential danger to the automobile's occupants and/or bystanders in the event of a car fire.

Combustion chamber (B) of generator unit 10A is formed from an outer, toroidally shaped, three-sided combustor cup 54, open along one longitudinal plane, which concentrically surrounds inner combustion container 56, configured to fit within cup 54. It is hermetically sealed by member 58 to prevent the entrance of moisture. Member 58 may be, for example, crimped along both its inner (i.e., in the vicinity of the igniter chamber) and outer peripheral edges so as to maintain container 56 in a closed condition prior to the operation of the generator unit.

Cup 54 is preferably formed of a metal, such as aluminum, to take advantage of the strength and heat conducting properties of this material. Optionally, however, cup 54 may be constructed of a thermoplastic material which is both cheaper and easier to manufacture, i.e., by extrusion. One consideration with the use of such a plastic, however, is the possible formation of toxic hydrocarbon reaction products, which should be

avoided in order to prevent the exposure of the vehicle's occupants to the effects of a toxic gas when the generator of the invention is used for air bag applications.

Into inner container 56 is placed the main propellant charge 60, which may be supplied in a variety of physical forms. It may, for example, be loaded as a powder or it may be inserted in the form of a number of substantially circular pellets, ranging in size from that of an aspirin tablet to an Alka-Seltzer®. Applicants have determined, however, that superior results are obtainable by forming the propellant charge into a series of pressed, flat, toroidal discs which may be maintained in a spaced arrangement so as to provide the maximum possible burning surface. This spaced arrangement is obtainable with the use of one or more raised ridges (not shown) or spacers extending upwardly from a portion of each disc, perpendicular to its longitudinal diameter, which facilitates the passage of a flame front in the space thus created therebetween.

A variety of compositions, well known to those of ordinary skill in the art, may be utilized as the main propellant charge for the generator assembly 10 described herein. Applicants prefer, for use in their assembly, the various compositions described in U.S. Patent no. 3,895,098 to John F. Pietz, issued July 15, 1975, now reissued as Re_____ and entitled METHOD AND COMPOSITION FOR GENERATING NITROGEN GAS, which is assigned of record to the assignee of the present invention. The disclosure of that patent is therefore incorporated herein by reference. Chief among these propellant compositions are those comprising a mixture of sodium azide with copper oxide.

Alternatively, compositions substituting nickel and iron oxidizers may be utilized, but these generants, although capable of a slightly higher effective gas output

than the CuO/NaN_3 mixture described above, often require the addition of an ammonium perchlorate burn rate enhancer to reach their full potential (as disclosed in U.S. Patent no. 4,604,151 issued on May 8, 1986 to Knowlton and Pietz, also incorporated herein by reference, entitled METHOD AND COMPOSITION FOR GENERATING NITROGEN GAS INCLUDING AMMONIUM PERCHLORATE CATALYST. This patent is also assigned of record to the present Assignee). Since, however, as discussed above, a large number of different generant compositions are operable within applicants' assembly 10, the present invention should not be limited to the preferred compositions disclosed above.

In an alternate embodiment of the invention, the propellant may be molded or extruded into a single porous grain which conforms to the volume and the shape of cup 54. Such a grain may be utilized with either a metal, e.g., aluminum, or plastic cup as disclosed above. An important feature to consider in the use of such a porous propellant grain, however, is whether the grain is formed having a great enough degree of porosity to provide a sufficient burning surface. This large burining surface is required to permit the flame front to advance through the grain with sufficient speed so as to provide a sufficient volume of gas within, for example, the 35-60 millisecond period described above.

The main propellant charge 60 is insulated against abrasion caused by contacting the top 58 and/or bottom 56 portions of the inner combustion container by the use of inert spacer pads 62, 64. Pads 62, 64 may be formed, for example, from a ceramic fiber comprising a mixture of alumina oxide and silica oxide and sold under the trade name of Fiberfrax® by Sohio Carborundum, Inc. of Niagara Falls, N.Y., a division of the Standard Oil Corp. Also located within container 56, between propellant 60 and combustion container 56 is pre-filter 66, comprised of a

series of fine-meshed metal screens to trap particulate material formed within the gas flow created by the combustion of propellant charge 60.

Upon ignition of the mixture 52 a,b within enhancer packet 50 by, for example, ignition squib 48, the hot gases thus produced pass through gas ports 68 located between the ignition chamber and the combustion chamber (as defined by combuster cup 54) and impinge against the inner annular portion of container 56, thus rapidly heating the container and the propellant charge 60 within.

Upon reaching the required ignition temperature for propellant 60, which may vary depending upon the propellant chosen, the walls of container 56 burst at a number of locations which abut gas ports 70 (preferably thirteen in number, although the amount may be varied), thus permitting the gas produced as a product of the combustion of propellant 60 to pass through prefiltering zone 66 and subsequently out of container 54 through gas ports 70.

Once the gas exits through ports 70, it is directed on a sinuous course as it enters slag filter 72, within the third zone (C) of the generator unit. Filter 72 is comprised of a twisted layer of a coarse steel wool material, capable of removing most of the remaining particulate material from the gas flow while also reducing the temperature of the flow. As the combustion of propellant 60 continues, forming additional gaseous products which exit through port 70 and enter filter 72, the gas presently within this zone is pushed out (as shown by the arrow) into filter 74. Filter 74 comprises several layers of mesh screen 74 a, b having a steadily decreasing mesh size from the inside out, which are separated by a spacer pad 74c of the type previously described. The

cooled, filtered gas then escapes from the generator through a plurality of diffuser ports 30 located around a peripheral portion of diffuser plate 22.

While it is apparent that the invention herein disclosed is well calculated to fulfill the objectives stated above, it will be appreciated that numerous modifications and embodiments may be devised by those skilled in the art, and it is intended that the appended claims cover all such modifications and embodiments as fall within the true spirit and scope of the present invention.

CLAIMS

We Claim:

1. A motor vehicle passive restraint system which comprises:

A. gas generator means capable of operation in the event of a collision involving said motor vehicle to produce a sufficient amount of a cool gaseous product, substantially devoid of undesirable particulate matter, to substantially inflate air bag means attached thereto in order to prevent secondary collisions between any occupants of said vehicle and an interior portion thereof, said generator means comprising

1) a mounting plate assembly comprising

(a) a base plate;

(b) a recessed portion for receiving and supporting a diffuser plate; and

(c) means for receiving and attaching an air bag, said means located along a peripheral portion of said mounting plate assembly,

said mounting plate assembly being integrally constructed of a relatively light weight material capable of being stamped utilizing conventional stamping equipment without any need to machine said assembly;

2) a diffuser plate having gas exhaust means configured and adapted for the passage of said gaseous product therethrough, said diffuser plate comprising

(a) a support plate configured for connection of said diffuser plate to said recessed portion of the mounting plate assembly, and

(b) at least one integral side wall portion extending from said support plate,

said diffuser plate being connected to said mounting plate assembly so as to cover said recessed portion and in a manner so as to permit a minimal degree of separation between said diffuser plate and said mounting plate assembly in the event said system becomes overpressurized; and

3) a gas generant composition capable of combustion so as to produce a desired amount of said gaseous product to inflate said air bag within less than about 60 milliseconds,

said mounting plate assembly and said diffuser plate forming a housing for said gas generant composition, and

B. air bag means attached by said receiving and attaching means to said mounting plate assembly and capable of inflation by said gaseous product produced by the operation of said generator means to protect said occupants during said collision.

2. The passive restraint system of claim 1 wherein said mounting plate assembly further comprises at least two recessed portions, each of said portions being configured and adapted for receiving and supporting a diffuser plate.

3. The passive restraint system of claim 2 wherein each said recessed portion is configured and adapted for supporting a separate, corresponding diffuser plate.

4. The passive restraint system of claim 1 wherein said diffuser plate is connected to said mounting plate assembly by fastener means selected from the group

consisting of bolts, rivets and screws, said means passing vertically through apertures defined by an outer peripheral portion of both said support plate and said recessed portion.

5. The passive restraint system of claim 4 wherein said diffuser plate further comprises a flanged portion located along a peripheral portion of said side wall portion, wherein said flanged portion is connected to said mounting plate assembly by a weld.

6. The passive restraint system of claim 1 wherein said means for receiving and attaching an air bag to said mounting plate assembly comprises a retainer ring mounted around a peripheral portion of said mounting plate assembly and fastener means extending through said ring for tightening said ring over a mouth portion of said air bag.

7. A motor vehicle passenger passive restraint system which comprises:

A. gas generator means capable of operation in the event of a collision involving said motor vehicle to produce a sufficient amount of a cool gaseous product, substantially devoid of undesirable particulate matter, to substantially inflate air bag means attached thereto in order to prevent secondary collisions between any passengers in said vehicle and an interior portion thereof, said generator means comprising

1) a mounting plate assembly comprising

(a) a base plate;

(b) a recessed portion for receiving and supporting a diffuser plate; and

(c) means for receiving and attaching an air bag, said means located along a peripheral portion of said mounting plate assembly,

said mounting plate assembly being integrally constructed of a relatively light weight material capable of being stamped utilizing conventional stamping equipment without any need to machine said assembly;

2) a diffuser plate having gas exhaust means configured and adapted for the passage of said gaseous product therethrough, said diffuser plate comprising

(a) a support plate configured for connection of said diffuser plate to said recessed portion of the mounting plate assembly and

(b) at least one integral side wall portion extending from said support plate,

said diffuser plate being connected to said mounting plate assembly so as to cover said recessed portion in a manner to permit a minimal degree of separation between said diffuser plate and said mounting plate assembly in the event said system becomes overpressurized; and

3) a gas generant composition capable of combustion so as to produce a desired amount of said gaseous product to inflate said air bag within less than about 60 milliseconds,

said mounting plate assembly and said diffuser plate forming a housing for said gas generant composition wherein said housing further comprises at least three concentrically aligned toroidal zones, whereby a first zone contains means for igniting said gas generant composition; a second zone contains said solid gas

generant composition operable upon ignition to produce gas and particulate reaction products; and a third zone contains filtration means to cool said gas and to trap said particulate products, said third zone being further provided with said gas exhaust means for discharging gas through said diffuser plate, and

B. air bag means attached by said receiving and attaching means to said mounting plate assembly and capable of inflation with said gaseous product produced by the operation of said generator means to protect said occupants during said collision.

8. The passenger restraint system of claim 7 wherein said mounting plate assembly further comprises at least two recessed portions, each of said portions being configured and adapted for receiving and supporting a separate, corresponding diffuser plate.

9. The passenger restraint system of claim 8 wherein each said diffuser plate is connected to said mounting plate assembly by fastener means selected from the group consisting of abolts, rivets and screws, said means passing vertically through apertures defined by an outer peripheral portion of said support plate and said corresponding recessed portion.

10. The passenger restraint system of claim 7 wherein said diffuser plate further comprises a flanged portion located along a peripheral portion of said side wall portion thereof, said flanged portion being connected to said base plate by a weld.

11. The passenger restraint system of claim 7 wherein said means for receiving and attaching an air bag to said mounting plate assembly comprises a retainer ring mounted

around a peripheral portion of said mounting plate assembly and fastener means extending through said ring for tightening said ring over a mouth portion of said air bag.

12. The passenger restraint device of claim 7 wherein said first zone of said housing contains enhancer packet means comprising a homogeneous mixture of an ignition enhancing material and an auto ignition composition.

13. The passenger restraint device of claim 12 wherein said second zone of said housing comprises prefiltering means located along an outer peripheral portion of said second zone, wherein said prefiltering means comprises at least one layer of screening means positioned so as to remove a portion of said particulate products from said gas.

14. The passenger restraint device of claim 13 wherein said third zone comprises a first portion containing first filtering means for removal of a major portion of said particulate reaction products from said gas, said first filtering means comprising chamber means substantially filled with a plurality of unaligned metal fibers, and a second portion containing second and third filtering means for removing substantially all of any remaining particulate reaction products from said gas, said second filtering means comprising screening means having a predetermined mesh size, said mesh size being sufficient to prevent the passage therethrough of substantially all of said particulate reaction products in said gas, and said third filtering means comprising screening means having a mesh size relatively narrower than that utilized with said second filtering means, whereby said gas passes through said second filtering means and subsequently through said third filtering means.

15. The passenger restraint device of claim 14 wherein said gas exhaust means comprise a plurality of diffusion ports located along a peripheral portion of said diffuser plate, adjacent and exterior to said third filtering means.

16. A motor vehicle passive restraint device constructed and arranged as hereinbefore described with reference to and as shown in the drawings.